

CLAIMS

What is claim is:

- 1) A bistable liquid crystal device comprising:
 - a first substrate having thereon a first conductive layer and a first alignment layer;
 - a second substrate having thereon a second conductive layer and a second alignment layer; and
 - a liquid crystal layer sandwiched between said first and second alignment layers, said first alignment layer inducing a first pretilt angle θ_1 in the range of 20° - 65° between said liquid crystal layer in contact with said first alignment layer, and said second alignment layer inducing a second pretilt angle θ_2 in the range of 20° - 65° between said liquid crystal layer in contact with said second alignment layer, said liquid crystal layer being capable of maintaining a stable bend state or a stable splay state at zero bias voltage and being switchable between said stable bend state and said stable splay state when a switching energy is applied in operation to said liquid crystal layer.
- 2) The device of claim 1, wherein said liquid crystal layer comprises liquid crystal having a positive dielectric birefringence when driven by electrical pulses at low frequency and a negative birefringence when driven by electrical pulses at high frequency.
- 3) The device of claim 1, wherein at least one of said first and second alignment layers comprises a mixture of vertical alignment material and horizontal alignment material.
- 4) The device of claim 1 further comprising input and output polarizers.
- 5) The device of claim 4 wherein said input and output polarizers respectively angle said alignment direction by $\pm 40^\circ$ to $\pm 60^\circ$.

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1 6) The device of claim 1 wherein said pretilt angles on said pair of substrates are
2 substantially different.

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1 7) The device of claim 1 wherein said pair of substrates have substantially parallel
2 alignment directions.

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1 8) The device of claim 1 wherein said switching energy is an electrical pulse
2 generated by said first and second conductive layers.

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1 9) The device of claim 1 wherein said switching energy is an electrical pulse having
2 low frequency to align said liquid crystal layer to said bend state.

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1 10) The device of claim 1 wherein said switching energy is an electrical pulse having
2 high frequency to align said liquid crystal layer to said splay state.

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1 11) The device of claim 1 wherein said switching energy is an electrical pulse
2 providing an electrical field in a predetermined direction between said pair of
3 substrates to switch said liquid crystal layer between said bend state and said splay
4 state.

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1 12) The device of claim 1 wherein one of said conductive layers further includes a
2 patterned electrode to provide an electrical field in a predetermined direction
3 between said pair of substrates to switch said liquid crystal layer between said
4 bend state and said splay state.

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1 13) The device of claim 1 wherein one of said conductive layers further includes a
2 patterned electrode, said patterned electrode having an interdigital structure so that
3 controlling the voltages on said interdigital electrode can apply either a vertical or

4 horizontal electric field upon said liquid crystal layer.

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1 14) The device of claim 1 wherein said first and second conductive layers are
2 patterned into stripes that are substantially perpendicular in direction to each other
3 to form an overlapping matrix of pixels.

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1 15) The device of claim 1 wherein both said first and second conductive layers are
2 transparent.

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1 16) The device of claim 1 wherein one of said first and second conductive layer is
2 optically reflecting.

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1 17) In a bistable liquid crystal device, said bistable liquid crystal device including a
2 first substrate having thereon a first conductive layer and a first alignment layer, a
3 second substrate having thereon a second conductive layer and a second alignment
4 layer, and a liquid crystal layer sandwiched between said first and second
5 alignment layers, a method for producing a bistable state comprising:

6 inducing a first pretilt angle θ_1 in the range of 20°-65° between said liquid crystal
7 layer in contact with said first alignment layer;

8 inducing a second pretilt angle θ_2 in the range of 20°-65° between said liquid
9 crystal layer in contact with said second alignment layer;

10 aligning said liquid crystal layer either in a stable bend state or in a stable splay
11 state at zero bias voltage; and

12 applying a switching energy to said liquid crystal layer to switch said liquid
13 crystal layer between said stable bend state and said stable splay state.

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1 18) The method of claim 17 wherein applying said switching energy further comprises
2 generating an electrical pulse by said first and second conductive layers.

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1 19) The method of claim 17 wherein applying said switching energy further comprises
2 applying a low frequency electrical pulse to align said liquid crystal layer to said
3 bend state.

1 20) The method of claim 17 wherein applying said switching energy further comprises
2 applying a high frequency electrical pulse to align said liquid crystal layer to said
3 splay state.

1 21) The method of claim 17 wherein applying said switching energy further comprises
2 generating an electrical field in a predetermined direction between said pair of
3 substrates to switch said liquid crystal layer between said bend state and said splay
4 state.

1 22) A bistable liquid crystal device comprising:

2 a first substrate having thereon a first conductive layer and a first alignment layer;
3 a second substrate having thereon a second conductive layer and a second
4 alignment layer; and

5 a liquid crystal layer sandwiched between said first and second alignment layers,
6 said liquid crystal layer having a positive dielectric anisotropy under a low
7 frequency electrical field and a negative dielectric anisotropy under a high
8 frequency electrical field, said first alignment layer inducing a first pretilt angle θ_1
9 in the range of 20°-65° between said liquid crystal layer in contact with said first
10 alignment layer, and said second alignment layer inducing a second pretilt angle
11 θ_2 in the range of 20°-65° between said liquid crystal layer in contact with said
12 second alignment layer, said liquid crystal layer

13 being either in a stable bend state or in a stable splay state at zero bias
14 voltage; and

15 being switchable between said stable bend state and said stable splay state
16 when a switching energy is applied in operation to said liquid crystal layer.

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- 1 23) A bistable liquid crystal device comprising:
- 2 a first substrate having thereon a first conductive layer and a first alignment layer;
- 3 a second substrate having thereon a second conductive layer and a second
- 4 alignment layer; and
- 5 a liquid crystal layer sandwiched between said first and second alignment layers,
- 6 said liquid crystal layer having a positive dielectric anisotropy and a cell gap-
- 7 birefringence product of $0.31 \pm 0.1 \mu\text{m}$, said first alignment layer inducing a first
- 8 pretilt angle θ_1 in the range of 20° - 65° between said liquid crystal layer in contact
- 9 with said first alignment layer, and said second alignment layer inducing a second
- 10 pretilt angle θ_2 in the range of 20° - 65° between said liquid crystal layer in contact
- 11 with said second alignment layer, said liquid crystal layer
- 12 being either in a stable bend state or in a stable splay state at zero bias
- 13 voltage; and
- 14 being switchable between said stable bend state and said stable splay state
- 15 when a switching energy is applied in operation to said liquid crystal layer.

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